Empirically derived dietary patterns and risk of postmenopausal breast cancer in a large prospective cohort study[1–3]

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ABSTRACT

Background: Inconsistent associations have been reported between diet and breast cancer.

Objective: We prospectively examined the association between dietary patterns and postmenopausal breast cancer risk in a US-wide cohort study.

Design: Data were analyzed from 40 559 women who completed a self-administered 61-item Block food-frequency questionnaire in the Breast Cancer Detection Demonstration Project, 1987–1998; 1868 of those women developed breast cancer. Dietary patterns were defined by using principal components factor analysis. Cox proportional hazard regression was used to assess breast cancer risk.

Results: Three major dietary patterns emerged: vegetable-fish/poultry-fruit, beef/pork-starch, and traditional southern. The vegetable-fish/poultry-fruit pattern was associated with higher education than were the other patterns, but was similar in nutrient intake to the traditional southern pattern. After adjustment for confounders, there was no significant association between the vegetable-fish/poultry-fruit and beef/pork-starch patterns and breast cancer. The traditional southern pattern, however, was associated with a nonsignificantly reduced breast cancer risk among all cases (in situ and invasive) that was significant for invasive breast cancer (relative hazard = 0.78; 95% CI = 0.65, 0.95; *P* for trend = 0.003). This diet was also associated with a reduced risk in women without a family history of breast cancer ($P = 0.05$), who were underweight or normal weight [body mass index (in kg/m^2) < 25; $P = 0.02$], or who had tumors positive for estrogen receptor ($P = 0.01$) or progesterone receptor ($P = 0.003$). Foods in the traditional southern pattern associated with reduced breast cancer risk were legumes, low mayonnaise–salad dressing intake, and possibly cabbage.

Conclusions: The traditional southern diet or its components are associated with a reduced risk of invasive breast cancer in postmenopausal women. *Am J Clin Nutr* 2005;82:1308–19.

KEY WORDS Breast cancer, dietary patterns, nutrition, factor analysis, cohort study

INTRODUCTION

Few modifiable risk factors for breast cancer have been identified (1); therefore, potential dietary associations are of particular interest. Associations between single nutrients and food components of the diet and breast cancer have been widely studied (2, 3), yet with inconsistent results (2, 4). The only well-established nutrition-related risk factors for postmenopausal breast cancer are obesity and alcohol intake (2, 4). High intakes of total fat and refined carbohydrate may increase breast cancer risk (2, 4, 5), and total vegetable intake—particularly cruciferous vegetable intake (6)—phytoestrogens (4), and fruit intake (2) may reduce risk, but the results of recent cohort studies measuring adult diet do not support an association (3, 7–9).

The examination of dietary patterns has been suggested as an alternative to quantify aggregate diet risk for chronic disease (10–16). Results from studies of single nutrients and foods may be inconsistent because they cannot disaggregate individual effects of highly correlated foods and may be unable to account for synergistic interactions of food combinations and constituents or other factors that may affect nutrient bioavailability (eg, cooking practices) (10–18). Dietary patterns are also more significantly associated with overall mortality and lowered risk of heart disease, high blood pressure, and possibly cancer than are single nutrients (15, 16, 18–21).

One common approach to defining empirical patterns of food intake is exploratory factor analysis, which is a statistical method used to combine correlated food items into a single exposure (12, 22). Patterns identified by factor analysis have been shown to be reliable and reasonably valid (16, 23–26). Two primary patterns have been identified in the United States through the use of this approach. The first pattern is characterized by intake of vegetables, fruit, whole grains, low-fat dairy products, fish, poultry, and often wine; the second is characterized by intake of red meats, refined grains, fat, sweets, and alcohol (13, 15, 16, 27, 28). The first pattern has been associated with decreased risk of obesity, diabetes, colon cancer, and cardiovascular disease; the inverse has been shown for the second pattern (14–16).

Dietary patterns have been suggested to be most useful in studying disease etiology when there is insufficient or conflicting

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evidence for diet associations, as is the case for breast cancer (13). Yet, only 3 published studies that we are aware of have examined dietary patterns and breast cancer risk (29–31). All used principal components factor analysis (PCFA) to define patterns. The first, which was conducted in Sweden, reported an increased risk associated with a "drinker" pattern (29). The second, which was conducted in northern Italy, observed a decreased risk associated with a raw salad vegetable pattern (30). The third, which was conducted among nurses in 11 northeastern US states, showed no overall association between a "prudent" or Western pattern and breast cancer risk but a reduced risk associated with the prudent pattern for estrogen-receptor-negative tumors (31).

Here we examine the association between dietary patterns of food items derived from PCFA and their potential association with breast cancer risk among postmenopausal women in a large, prospective cohort study in the United States. Given evidence that family history of breast cancer (32), body mass index (BMI) (30), hormone receptor status (33, 34), and history of benign breast disease (BBD) (35) may modify diet–breast cancer associations, we further examined potential interactions with these factors.

SUBJECTS AND METHODS

Study population

Study subjects were participants in the Breast Cancer Detection Demonstration Project (BCDDP) follow-up cohort study, the details of which were provided previously (36). Briefly, participants were selected from >280 000 past participants in the BCDDP breast cancer screening program conducted between 1973 and 1981 at 29 centers throughout the United States. Beginning in 1979, the National Cancer Institute (NCI) began a follow-up cohort study on a subset of BCDDP participants (n = 64 182). Women were selected for follow-up on the basis of their status at their last screening visit: diagnosis of breast cancer (n = 4275), nonmalignant or BBD determined by biopsy or breast surgery (n = 25 114), and recommended for biopsy or breast surgery but did not have the surgery performed (n = 9628). In addition, a sample of women identified by screening to have no evidence of breast disease were included (n = 25 165). Data were collected 5 times: during the first screening visit (1973–1975), during the phase I baseline interview (1979–1986), during phase II (1987–1989), during phase III (1993–1995), and during phase IV (1995–1998). All attempts were made to interview nonresponders, and extensive efforts were made to locate women lost to follow-up, including attempted tracing through the National Center for Health Statistics National Death Index through 31 December 1997. The follow-up study was approved by the NCI Institutional Review Board, and informed consent was obtained from the participants.

Dietary assessment

Dietary intake information was assessed by using the self-administered Block–NCI 61-item food-frequency questionnaire (FFQ) (37, 38) during phase II (1987–1989). Women were asked to report their usual intake during the previous year. The FFQ has been described in detail, and its validity and reproducibility are reported elsewhere (39, 40). Average daily intakes of nutrients and total energy intake were calculated with software developed for the survey instrument. The frequency of consumption of each food was multiplied by reported portion size to obtain gram intake, which was then multiplied by the nutrient content of that food (37). To standardize reports of food consumption into similar units, intakes were converted to medium servings by dividing reported gram intake by the gram amount in a medium serving [as defined by the Block-NCI software (37)]. To also standardize diets to similar caloric intakes given different body sizes and physical activity levels, servings of daily food intake per 1000 kcal were calculated by dividing the intake of each food item by reported total energy intake and multiplying the result by 1000. Questionnaires with reported caloric intakes of <400 or ≥3800 kcal/d and those with ≥30 skipped food items were considered invalid and were excluded from the analyses (n = 5080; 11% of the 46 331 eligible women who completed the questionnaire).

Covariates

Education level was obtained at the first screening visit (1973–1975). Information about family history of breast cancer in a first-degree relative, history of biopsies for BBD, self-reported race, use of female hormones or oral contraceptives, age at menarche, parity, age at first live birth, and menopausal age was obtained at baseline and through annual telephone interviews (1979–1986) and was updated through subsequent mailed follow-up questionnaires. Alcohol intake, physical activity, weight, height, tobacco use, and average hours of weekday vigorous physical activity were reported during phase II. BMI was defined as weight in kilograms divided by squared height in meters. Region of residence was obtained from reported address during phase III, or if missing, phase IV, and was grouped into Northeast (including New England and the mid-Atlantic states), North/Midwest (including the Midwest, Mountain, and Northwest regions), Southwest (including California and Hawaii), and Southeast (including the South Atlantic and Central Southeast regions) (41).

Analytic cohort

In this analysis, postmenopausal women were followed from the time of the FFQ administration in phase II through phase IV. Of the 64 182 women selected for participation in the follow-up study, 61 431 (96%) completed the baseline interview and were available for study. Of these, women who were premenopausal at phase IV (n = 66) or who had received a diagnosis of breast cancer before or at the time of completion of phase II (n = 6528) were considered ineligible and were excluded from the analyses. Menopause was defined as being anovulatory for the previous 3 mo. Women reporting surgical menopause without removal of both ovaries were considered menopausal when they reached 57 y of age (75th percentile for age at menopause in the cohort) or their age at hysterectomy, whichever came last. We further consecutively excluded women from analyses for the following reasons: unknown or missing menopausal data (n = 382), did not complete phase II (n = 8124), FFQ considered unusable (n = 5080), inappropriate entry and exit dates (n = 336), and missing covariate information for parity, age at first live birth, and education (n = 351). In the multivariate analyses, missing information for age at menarche (0.4%) was imputed on the basis of the mean value for the cohort; that for BMI (6%), height (5%), and vigorous weekday physical activity (13%) was imputed on the basis of the mean value within strata of 5-y age intervals at phase

II. For family history of breast cancer, missing information was included as "don't know." At the administration of the phase II questionnaire, 87% of the analytic cohort was postmenopausal and 13% became menopausal between the second and fourth phases of the study. The final analytic cohort included 40 559 women (74% of them eligible). Ten percent of the women were lost to follow-up (4005 of 40 559).

Case ascertainment

Breast cancer status was obtained from self-report, relatives, linkage of the cohort to state registries, and reports of breast cancer on death certificates through linkage to the National Death Index. Of the 1868 postmenopausal women who developed breast cancer in the analytic cohort, 1666 (89%) were confirmed by pathology report and 202 (11%) were self-reported only. The accuracy of self-reported cases with pathology reports was high (87% confirmed as cancers). Among cases with pathology reports, 1365 were confirmed as invasive, 300 as in situ, and 1 as undetermined. Only 2% of cancers ($n = 43$) were identified only by linkage to state registries. Among the total of 1868 cases, information on the ER status of the tumor was available for 1036 tumors (55%).

Identification of dietary patterns

Dietary patterns were defined by using PCFA to identify underlying factors (dietary patterns) on the basis of the correlation of the 61 food items from the FFQ (22, 42). Food items were included in the PCFA as medium servings per day per 1000 kcal. PCFA was used on standardized variables to identify factors that accounted for as much of the total variance in the food items as possible. Retained factors were orthogonally rotated by using the varimax method so that the factors were uncorrelated. For each identified factor, only a few food items received large loadings, making a more meaningful interpretation of factors possible (42). We used the scree plot, as well as interpretability of identified patterns, to retain 3 primary factors, which we labeled the vegetable-fish/poultry-fruit, beef/pork-starch, and traditional southern patterns. These 3 factors together explained 12.5% of the total variance (4.6%, 4.6%, and 3.3%, respectively), which was an expected percentage given the detail in the foods included (ie, 61 food items) and that a correlation matrix was used with PCFA (15, 43). For each woman, a score for each of the 3 identified dietary patterns was then calculated by summing intakes of the 61 food items weighted by their factor loadings.

To examine the robustness of the identified dietary patterns, we used several approaches. First, we grouped the food items into 25 unique food groups based on the US Department of Agriculture pyramid food groups (44) and included these in the PCFA analyses; the patterns identified were similar but not as readily interpretable as with all 61 food items (43). Second, we applied image and maximum likelihood factor analysis (22, 42). Image analysis attempts to identify the common (factor) and unique (error) components of a model, and maximum likelihood analysis assumes the normality of data, which can lead to a failure to converge for large data sets with large numbers of variables. The results of the image factor analysis gave essentially the same results as the PCFA but were not as robust as with PCFA when outlier food intake values were included (42). Third, using PCFA, we used an alternate orthogonal rotation, quartimax, and an oblique rotation technique, promax, but the results for both were largely similar to the varimax rotation. Fourth, we repeated the PCFA while retaining in the analyses only those of the 61 food items with an absolute factor loading $\geq$0.2 for any of the 3 dietary patterns (14 food items were dropped). Patterns were little changed, and only the percentage total variance explained by each factor increased with fewer food items, as expected (to 5.8%, 5.8%, and 4.0% for the new vegetable-fish/poultry-fruit, beef/pork-starch, and traditional southern patterns, respectively). Last, we conducted stratified PCFA analyses by both history of BBD and region of the United States. Factor loadings were nearly identical to the third decimal for women with and without a history of BBD. Within each region, the same, nearly identical patterns were also observed with minor modifications. Further, when alcohol intake was removed from the PCFA, the same diet patterns were observed with nearly identical factor loadings. Given the robustness in the patterns identified by these different approaches, we calculated pattern scores in all future analyses by using results from the original overall PCFA.

Statistical analysis

Relative hazards and 95% CIs were estimated by using Cox proportional hazards regression with age as the underlying time metric. SAS software (version 9) was used for all analyses (45). Subjects were considered to have entered the cohort at their second-phase interview or date of menopause, whichever came later, and to have exited the study at their diagnosis of breast cancer, death from other causes, last contact, date of bilateral prophylactic mastectomy, or return of the follow-up questionnaire, whichever came first.

Relative hazards associated with each dietary pattern factor score were examined both on the basis of quintiles defined for the entire population and as continuous variables. Food items were grouped as never consumed and, among consumers, categorized into tertiles. An index of food items associated with reduced breast cancer risk in the traditional southern pattern (increased cabbage and legume intake and decreased mayonnaise–salad dressing intake) was also created by combining standardized z score distributions of each food item. Risk functions were modeled as both linear and quadratic functions, and likelihood ratio tests comparing nested models were examined to determine the best fit. Tests for linear trend were calculated by using continuous variables modeled as linear terms (Wald test statistic) except as noted in one table, in which tests for trend were calculated on the basis of the median values of the categories because of the large number of women who never ate individual foods. The likelihood ratio test was used to test for interaction. All tests of significance were 2-sided.

In addition to identified factors, we included the following established and suspected risk factors for breast cancer in multivariate analyses: total energy intake (linear), BMI (quadratic function), height (linear), first-degree family history of breast cancer (yes, no, or don't know), parity (yes, no, and linear), age at first live birth (linear), use of exogenous hormones in the year before the phase II interview (yes or no), age at menarche (linear), alcohol use (yes, no, and quadratic function), hours of vigorous weekday physical activity (linear), smoking status (never, current, or former), and education (less than high school graduate, high school graduate, some college, college graduate, or higher). We also examined the effect of the number of weekly servings of fruit and vegetables consumed (linear) on adjusted estimates.

TABLE 1
Factor loadings using principal components factor analysis (PCFA) for foods associated with dietary patterns among postmenopausal women in the Breast Cancer Detection Demonstration Project cohort study, 1987–1998[1]

Vegetable-fish/poultry-fruit		Beef/pork-starch		Traditional southern	
Food item	Loading	Food item	Loading	Food item	Loading
Green salad	0.57	Pork chops and roasts	0.46	Cooked greens	0.46
Broccoli	0.52	Beef steaks and roasts	0.46	Beans and legumes, baked and cooked	0.39
Fish, broiled or baked	0.46	Bacon	0.45	Sweet potatoes	0.36
Chicken, broiled or baked	0.44	Hamburger	0.44	Corn bread, muffins, and tortillas	0.32
Carrots and mixed vegetables	0.43	French fries and fried potatoes	0.42	Coleslaw, cabbage, and sauerkraut	0.31
Tomatoes and tomato juice	0.40	Sausage	0.40	Fish, fried	0.30
Spinach, raw and cooked	0.40	Chicken, fried	0.38	Cereal, cooked	0.28
Apples, applesauce, and pears	0.30	Hot dogs	0.29	Rice	0.27
Coleslaw, cabbage, and sauerkraut	0.27	Eggs	0.28	Chicken, fried	0.25
Grapefruit	0.27	Liver	0.26	Beef stew and pot pie	0.24
Cantaloupe	0.26	Ham and lunch meats	0.25	Fruit drinks	0.24
Oranges	0.25	Beef stew and pot pie	0.23	Carrots and mixed vegetables	0.20
Doughnuts, cookies, and cakes	−0.37	Bran and granola cereal, cold	−0.38	Cheese and cheese spread	−0.35
Ice cream	−0.26	Skim milk	−0.36	Mayonnaise and salad dressing	−0.31
All pies	−0.25	Chicken, broiled and baked	−0.34	Wine	−0.31
2%-Fat milk	−0.23	Fish, broiled and baked	−0.33	Liquor	−0.30
Chocolate candy	−0.22	Dark bread	−0.29	Salty snacks	−0.20
White bread and rolls	−0.22	Cereal, cooked	−0.25		
Dry cereal, cold	−0.20	Apples	−0.22		

[1] $n = 40\,559$. PCFA on 61 food items as servings/1000 kcal; reported |factor loadings| ≥0.2.

We further examined stratified analyses and potential interactions between identified dietary patterns and breast cancer risk by family history of breast cancer (yes, no, or not sure), BMI (<25, 25–30, and >30), and history of BBD (yes or no). To ensure an appropriate multivariate model fit, we also tested for the presence of interactions with all other covariates included in the multivariate analyses.

RESULTS

Study participants ($n = 40\,559$) were 62 y of age at the start of follow-up (range: 40–91 y) and were followed for 8 y on average. They were predominantly white (89%), parous (87%), had ≥12 y of education (89%) and their state of residence was fairly evenly distributed throughout the United States (Northeast, 15%; North-Midwest, 36%; Southeast, 26%; and Southwest, 23%). Also, at baseline, 22% had a first-degree family history of breast cancer and 66% had a history of BBD. Postmenopausal breast cancer was diagnosed at ages <60, 60–65, 66–70, 71–75, and >75 y for 39%, 25%, 19%, 11%, and 6% of women, respectively.

Dietary patterns

We identified 3 primary dietary patterns (**Table 1**). The first, labeled vegetable-fish/poultry-fruit*,* was characterized by high intakes of vegetables and broiled or baked fish and chicken and low intakes of sweets and white bread. The second, labeled beef/pork-starch*,* was characterized by high intakes of pork, beef, processed meat, French fries, and eggs and low intakes of bran cereal, skim milk, broiled or baked fish and chicken, and dark bread. The third, labeled traditional southern*,* was characterized by high intakes of traditional rural southern US foods (46), including cooked greens (ie, collard, kale, and other greens), cooked beans and legumes (ie, pinto, lima, kidney, and baked), sweet potatoes, cornbread, cabbage (coleslaw, cooked cabbage, and sauerkraut), fried fish and chicken, and rice and low intakes of cheese, mayonnaise–salad dressing, wine, liquor, and salty snacks.

Select characteristics within quintiles of dietary patterns are shown in **Table 2**. Women in the highest quintiles of each pattern represented all regions of the United States and all race/ethnicities. For the traditional southern diet, for example, 12.2% of women in the highest quintile were from the Northeast, 24.8% were from the North-Midwest, 30.9% were from the Southwest, and 32.1% were from the Southeast. Also, 70% were white, 11% were black, 4% were Hispanic, 14% were of other race/ethnicities (primarily Asian), and 1% were of unknown race/ethnicity (data not shown). For the vegetable-fish/poultry-fruit pattern, women in the highest quintile of intake were more likely than women in the lowest quintile of intake to have some college or be a college graduate (28.1% compared with 14.9%), to be from the southwestern region of the United States (27.4% compared with 17.8%), to drink ≥13 g alcohol/d (16.9% compared with 2.6%), to be former (37.8% compared with 24.0%) and not current smokers (11.3% compared with 13.7%), and to have an earlier age at menarche (≤12 y; 45.8% compared with 40.4%). They were also less likely to be obese (9.5% compared with 12.0%). Women in the highest compared with the lowest quintile of intake of the beef/pork-starch pattern were younger ($\bar{x}$: 60.2 compared with 63.7 y), less likely to have some college or be a college graduate (14.0% compared with 28.3%), more likely to be from the North/Midwest (37.2% compared with 32.4%) or Southeast (32.3% compared with 22.2%), more likely to drink ≥13 g alcohol/d (11.8% compared with 5.4%), and much more likely to smoke (21.5% compared with 6.2%) and to be obese (16.7% compared with 7.2%). Women in the highest compared with lowest quintile of the traditional southern pattern were much more likely to have less than a high school education (19.0% compared with 5.6%), more likely to be black (11.2% compared with 0.8%) and from the Southwest (30.9% compared with

TABLE 2
Select characteristics within quintiles (Q) of dietary patterns among postmenopausal women in the Breast Cancer Detection Demonstration Project cohort study, 1987–1998[1]

	Vegetable-fish/poultry-fruit			Beef/pork-starch			Traditional southern		
Select characteristics	Q1	Q3	Q5	Q1	Q3	Q5	Q1	Q3	Q5
Age (y)	62.7 ± 8.7[2]	61.7 ± 7.9	61.3 ± 7.3	63.7 ± 7.9	61.9 ± 7.9	60.2 ± 7.7	60.1 ± 7.2	61.9 ± 7.8	63.4 ± 8.3
P[3]		< 0.001			< 0.001			< 0.001	
Education (%)									
< High school	17.0	10.4	7.5	8.1	9.7	17.4	5.6	10.3	19.0
High school graduate	47.7	42.8	37.2	38.4	42.2	48.5	39.1	45.2	42.2
Some college	20.4	24.8	27.2	25.2	25.3	20.2	26.2	23.4	21.8
College graduate	14.9	22.5	28.1	28.3	22.9	14.0	29.2	21.1	17.1
P[3]		< 0.001			< 0.001			< 0.001	
Race (%)									
Black	4.5	3.6	3.3	3.1	3.0	6.5	0.8	2.1	11.2
White	89.1	87.7	89.5	90.7	89.3	84.3	97.1	92.9	69.9
Hispanic	2.0	1.6	1.7	1.4	1.7	2.6	0.9	1.4	3.8
Other or unknown	4.5	7.1	5.5	4.8	6.0	6.6	1.2	3.6	15.0
P[3]		< 0.001			< 0.001			< 0.001	
Region (%)									
Northeast	15.0	13.8	16.9	19.6	14.8	11.0	19.0	14.4	12.2
North/Midwest	35.7	37.4	32.7	32.4	36.6	37.2	36.6	40.9	24.8
Southwest	17.8	23.1	27.4	25.8	23.2	19.5	22.6	19.5	30.9
Southeast	31.4	25.7	23.0	22.2	25.4	32.3	21.8	25.2	32.1
P[3]		< 0.001			< 0.001			< 0.001	
Age at menarche (%)									
≤12 y	40.4	43.7	45.8	44.8	43.1	42.1	45.4	42.9	41.2
13 to <15 y	46.4	45.3	43.9	44.6	45.1	45.1	44.8	46.6	45.1
≥15 y	13.2	11.0	10.3	10.6	11.8	12.8	9.8	10.5	13.7
P[3]		< 0.001			< 0.001			< 0.001	
Parity (%)									
Nulliparous	14.0	12.7	12.8	14.9	13.0	12.5	13.2	12.4	14.3
1	12.9	11.1	10.9	12.0	11.2	11.7	9.9	11.1	13.6
2	28.0	29.2	31.5	31.8	29.4	27.6	30.8	29.1	28.0
3	21.8	24.2	25.0	23.9	24.1	22.8	25.4	23.8	22.1
≥4	23.3	22.8	19.8	17.4	22.4	25.4	20.7	23.6	22.1
P[3]		<0.001			< 0.001			< 0.001	
Age at first live birth (y)	23.4 ± 4.5	23.8 ± 4.4	24.0 ± 4.2	24.5 ± 4.3	23.9 ± 4.4	22.9 ± 4.4	24.0 ± 4.1	23.8 ± 4.4	23.4 ± 4.6
P[3]		<0.001			< 0.001			< 0.001	
BMI (%)									
< 18.5 kg/m^2	2.8	2.2	2.4	3.0	2.3	2.1	2.2	2.0	3.1
18.5 to <25.0 kg/m^2	53.3	53.7	57.5	61.8	55.5	46.8	56.7	53.5	55.1
25 to <30 kg/m^2	32.0	32.3	30.6	28.0	32.2	34.4	30.6	32.2	31.3
≥ 30 kg/m^2	12.0	11.8	9.5	7.2	10.0	16.7	10.5	12.3	10.5
P[3]		< 0.001			< 0.001			< 0.001	
Height (m)	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1
P[3]		0.96			< 0.001			< 0.001	
Family history of breast cancer (%)									
No	74.8	75.2	75.2	75.3	75.6	74.7	74.1	3.2	75.4
Yes	21.6	21.9	21.7	21.7	21.5	21.9	22.5	21.8	21.2
Unknown	3.5	3.0	3.1	3.0	3.0	3.4	3.4	75.0	3.4
P[3]		0.67			0.31			0.36	
Hormone replacement therapy use (%)									
Nonuser	96.1	95.3	95.8	95.9	95.9	95.9	94.9	95.5	97.0
User	3.9	4.7	4.2	4.1	4.1	4.1	5.1	4.5	3.0
P[3]		0.08			0.71			< 0.001	
Vigorous physical activity (h/wk)	1.2 ± 1.7	1.2 ± 1.6	1.2 ± 1.5	1.1 ± 1.5	1.2 ± 1.6	1.3 ± 1.8	1.0 ± 1.5	1.2 ± 1.6	1.4 ± 1.6
P[3]		0.09			<0.001			< 0.001	
Alcohol (%)									
0 g/d	63.6	46.6	41.2	53.3	46.7	52.1	24.9	50.9	70.5
1–13 g/d	33.9	42.7	41.9	41.4	41.9	36.0	42.7	44.3	28.5
>13 g/d	2.6	10.7	16.9	5.4	11.4	11.8	32.4	4.8	1.1
P[3]		< 0.001			< 0.001			< 0.001	
Smoking (%)									
Never	62.3	57.7	50.9	59.9	57.1	53.9	41.4	57.5	67.9
Former	24.0	30.1	37.8	33.9	31.8	24.7	41.4	29.1	22.4
Current	13.7	12.1	11.3	6.2	11.2	21.5	17.2	11.4	9.7
P[3]		< 0.001			< 0.001			< 0.001	

(*Continued*)

TABLE 2 (*Continued*)

	Vegetable-fish/poultry-fruit			Beef/pork-starch			Traditional southern		
Select characteristics	Q1	Q3	Q5	Q1	Q3	Q5	Q1	Q3	Q5
Food and nutrient intakes per 1000 kcal									
Total energy (kcal)	1463.5 ± 611.5	1299.5 ± 495.7	1048.2 ± 409.1	1198.8 ± 529.9	1314.0 ± 517.9	1282.3 ± 539.9	1347.4 ± 556.0	1299.8 ± 520.1	1168.0 ± 501.9
P^3		< 0.001			< 0.001			< 0.001	
Total vegetables (servings)	1.1 ± 0.6	1.8 ± 0.8	3.1 ± 1.7	2.1 ± 1.3	1.9 ± 1.2	1.9 ± 1.2	1.8 ± 1.2	1.9 ± 1.3	2.4 ± 1.4
P^3		< 0.001			< 0.001			< 0.001	
Total fruit (servings)	0.8 ± 0.8	1.1 ± 0.9	1.6 ± 1.0	1.5 ± 1.1	1.1 ± 0.9	0.8 ± 0.7	0.9 ± 0.8	1.2 ± 0.9	1.4 ± 1.0
P^3		< 0.001			< 0.001			< 0.001	
Pork, beef, and liver (servings)	0.5 ± 0.3	0.6 ± 0.4	0.4 ± 0.4	0.2 ± 0.1	0.5 ± 0.2	1.0 ± 0.4	0.5 ± 0.4	0.5 ± 0.3	0.5 ± 0.4
P^3		< 0.001			< 0.001			0.001	
Fish and chicken, grilled and baked (servings)	0.2 ± 0.2	0.3 ± 0.3	0.7 ± 0.5	0.6 ± 0.5	0.3 ± 0.2	0.2 ± 0.2	0.4 ± 0.4	0.3 ± 0.3	0.4 ± 0.3
P^3		< 0.001			< 0.001			< 0.001	
Saturated fat (g)	14.4 ± 3.6	13.0 ± 3.6	10.7 ± 3.5	9.6 ± 3.3	13.1 ± 3.3	15.4 ± 3.2	14.3 ± 4.1	12.9 ± 3.5	11.1 ± 3.5
P^3		< 0.001			< 0.001			< 0.001	
Folate (μg)	197.5 ± 140.0	213.0 ± 96.0	246.5 ± 90.8	276.5 ± 140.7	211.4 ± 88.8	170.6 ± 69.4	180.3 ± 78.7	218.7 ± 104.1	248.6 ± 122.2
P^3		< 0.001			< 0.001			< 0.001	
Fiber (g)	7.1 ± 2.8	9.1 ± 3.0	12.2 ± 4.1	11.7 ± 4.0	9.1 ± 3.3	7.6 ± 3.0	7.4 ± 3.0	9.2 ± 3.3	11.6 ± 4.1
P^3		< 0.001			< 0.001			< 0.001	

[1] n = 40 559.
[2] $\bar{x} \pm$ SD (all such values).
[3] ANOVA test comparing mean quintile difference for continuous variables and the chi-square test comparing percentile difference for categorical variables.

22.6%) or Southeast (32.1% compared with 21.8%), far less likely to drink ≥13 g alcohol/d (1.1% compared with 32.4%), and were more likely to never have smoked (67.9% compared with 41.4%) and have a late age at menarche (≥15 y; 13.7% compared with 9.8%). Select dietary characteristics were associated with the 3 patterns in a manner consistent with our expectations (see Table 2).

In **Table 3** we present the adjusted relative hazard (RH) of

TABLE 3
Adjusted relative hazard (RH) of breast cancer by quintiles (Q) of dietary patterns among postmenopausal women in the Breast Cancer Detection Demonstration Project cohort study, 1987–1998[1]

	Adjusted RH (95% CI)					
Dietary pattern	Q1	Q2	Q3	Q4	Q5	P for linear trend[2]
Vegetable-fish/poultry-fruit						
No. of total cases[3]	341	391	378	386	372	
Age- and energy-adjusted	Ref	1.15 (1.00, 1.34)	1.13 (0.97, 1.30)	1.16 (1.00, 1.35)	1.13 (0.97, 1.32)	0.17
Multivariate RH (95% CI)[4]	Ref	1.12 (0.97, 1.30)	1.07 (0.92, 1.24)	1.07 (0.92, 1.25)	1.03 (0.88, 1.20)	0.95
No. of invasive BC cases[5]	245	290	272	284	274	
Multivariate RH (95% CI)[4]	Ref	1.15 (0.97, 1.37)	1.06 (0.89, 1.27)	1.09 (0.91, 1.30)	1.04 (0.87, 1.26)	0.77
Beef/pork-starch						
No. of total cases[3]	392	399	365	350	362	
Age- and energy-adjusted	Ref	1.04 (0.90, 1.19)	0.96 (0.83, 1.11)	0.94 (0.81, 1.09)	1.01 (0.87, 1.16)	0.45
Multivariate RH (95% CI)[4]	Ref	1.03 (0.89, 1.18)	0.96 (0.83, 1.11)	0.95 (0.82, 1.10)	1.03 (0.89, 1.20)	0.70
No. of invasive BC cases[5]	283	294	263	262	263	
Multivariate RH (95% CI)[4]	Ref	1.05 (0.89, 1.23)	0.96 (0.81, 1.13)	0.98 (0.82, 1.16)	1.04 (0.87, 1.23)	0.53
Traditional southern						
No. of total cases[3]	410	374	382	360	342	
Age- and energy-adjusted	Ref	0.89 (0.77, 1.02)	0.90 (0.78, 1.04)	0.83 (0.72, 0.96)	0.79 (0.68, 0.91)	0.001
Multivariate RH (95% CI)[4]	Ref	0.95 (0.82, 1.10)	0.98 (0.84, 1.14)	0.92 (0.79, 1.07)	0.89 (0.76, 1.05)	0.21[6]
No. of invasive BC cases[5]	318	275	280	256	236	
Multivariate RH (95% CI)[4]	Ref	0.89 (0.75, 1.05)	0.92 (0.77, 1.09)	0.83 (0.70, 1.00)	0.78 (0.65, 0.95)	0.003

[1] n = 40 559. Ref, referent; BC, breast cancer. Adjusted RH from Cox proportional hazard regression.
[2] Wald test for linear trend.
[3] All breast cancer cases (in situ and invasive); n = 1868.
[4] Adjusted for age, total energy intake, education, family history of breast cancer, BMI, height, parity, age at first live birth, age at menarche, menopausal hormone use, average weekday vigorous physical activity, smoking status, and alcohol use.
[5] Histologically confirmed invasive breast cancer; n = 1365.
[6] Risk function best modeled as quadratic function (P for likelihood ratio test = 0.03).

breast cancer by quintiles of intake of each dietary pattern. Neither the vegetable-fish/poultry-fruit nor the beef-pork-starch pattern was associated with breast cancer risk (*P* for trend NS). For the traditional southern pattern, by contrast, comparing the highest with the lowest quintile of intake in analyses adjusted for age and energy intake, the RH was 0.79 (95% CI: 0.68, 0.91; *P* for linear trend = 0.001), but the adjusted RH was not significant (RH = 0.89; 95% CI: 0.76, 1.05). When all 3 patterns were included simultaneously in adjusted analyses, the results for the traditional southern pattern were almost identical (data not shown). Sample size was limited in the analyses examining the cross-products of the traditional southern pattern with the other 2 patterns, but relative to the lowest quintile of both the traditional southern and the vegetable-fish/poultry-fruit pattern, the RH was 0.75 (95% CI: 0.53, 1.09); relative to the highest quintile of the beef/pork-starch and lowest quintile of the traditional southern pattern, the RH was 0.79 (95% CI: 0.62, 1.13; data not shown). When only confirmed invasive breast cancer cases were included in the analyses (n = 1365), however, the traditional southern pattern was associated with a significantly reduced risk of breast cancer in the full multivariate model (RH for the highest compared with the lowest quintile = 0.78; 95% CI: 0.65, 0.95; *P* for linear trend = 0.003).

To determine whether women who developed breast cancer might have distinctly different dietary patterns from those who did not, we conducted PCFA analyses within strata of women with and without breast cancer. The same 3 patterns were observed among both groups of women with nearly identical factor loadings for each food item (data not shown).

In **Table 4** we examine the adjusted RH of breast cancer associated with quintiles of intake of the traditional southern pattern within strata of family history of breast cancer, BMI, history of BBD, and smoking because diet–breast cancer interactions were previously reported for these factors (30–32, 35). We also examined interactions between these factors and the other 2 diet patterns and observed no evidence ($P > 0.05$) of an interaction (data not shown). We observed an interaction between family history of breast cancer and the traditional southern pattern (*P* for interaction = 0.002), in which there was a lower risk only for women without a family history of breast cancer (*P* for linear trend = 0.05). We also observed an interaction between BMI and the traditional southern dietary pattern (*P* for interaction = 0.03); in analyses stratified by BMI, only among women who were underweight or normal weight for height (BMI < 25) was the traditional southern diet associated with a reduced breast cancer risk (*P* for linear trend = 0.03). By contrast, among women who were obese (BMI ≥ 30), breast cancer risk increased (RH = 1.59; 95% CI: 0.97, 2.60), although there was no dose-response effect (*P* for linear trend = 0.19). We observed no interaction with history of BBD (P = 0.90). We observed an interaction between the traditional southern diet and smoking (*P* for interaction = 0.01), in which a higher intake of the traditional southern dietary pattern among current smokers was associated with reduced breast cancer risk (*P* for linear trend = 0.008), although risk was similarly decreased for all other quintiles. We also conducted stratified analyses by alcohol intake in order to fully disentangle the effects of alcohol from the other foods items in the traditional southern diet, but saw little evidence for heterogeneity in breast cancer risk associated with the traditional southern diet pattern between nondrinkers and women who

TABLE 4
Adjusted relative hazard (RH) of breast cancer by quintiles (Q) of the traditional southern dietary pattern within strata of covariates of interest among postmenopausal women in the Breast Cancer Detection Demonstration Project cohort study, 1987–1998[1]

Dietary pattern	No. of cases[2]	Adjusted RH (95% CI)					*P* for linear trend[3]
		Q1	Q2	Q3	Q4	Q5	
Family history of breast cancer							
No	1239	Ref	0.90 (0.75, 1.08)	0.98 (0.82, 1.18)	0.91 (0.75, 1.10)	0.83 (0.68, 1.01)	0.05
Unknown	70	Ref	0.49 (0.22, 1.09)	0.88 (0.44, 1.74)	0.62 (0.29, 1.31)	0.34 (0.14, 0.82)	0.09
Yes	559	Ref	1.14 (0.87, 1.51)	1.00 (0.74, 1.33)	1.01 (0.75, 1.35)	1.17 (0.87, 1.58)	0.19
P value for interaction[4]				0.002			
BMI (kg/m^2)							
<25.0	1024	Ref	1.03 (0.84, 1.25)	1.00 (0.82, 1.22)	0.92 (0.75, 1.14)	0.79 (0.63, 0.99)	0.02
25 to <30	630	Ref	0.74 (0.57, 0.96)	0.81 (0.63, 1.05)	0.81 (0.62, 1.05)	0.88 (0.68, 1.14)	0.92
≥30	214	Ref	1.32 (0.82, 2.13)	1.58 (0.99, 2.52)	1.36 (0.83, 2.22)	1.59 (0.97, 2.60)	0.19
P for interaction[4]				0.03			
History of benign breast disease							
No	481	Ref	1.01 (0.76, 1.35)	0.92 (0.68, 1.24)	1.09 (0.81, 1.48)	0.85 (0.61, 1.18)	—
Yes	1387	Ref	0.92 (0.77, 1.09)	1.00 (0.84, 1.18)	0.86 (0.71, 1.03)	0.90 (0.75, 1.08)	—
P for interaction[4]				0.90			
Smoking							
Never	1046	Ref	1.02 (0.82, 1.28)	1.09 (0.87, 1.35)	1.02 (0.82, 1.28)	1.02 (0.82, 1.28)	0.95
Former	611	Ref	1.02 (0.80, 1.28)	1.08 (0.85, 1.38)	0.97 (0.74, 1.27)	0.85 (0.63, 1.14)	0.56
Current	211	Ref	0.69 (0.47, 1.01)	0.59 (0.38, 0.91)	0.58 (0.37, 0.92)	0.58 (0.36, 0.94)	0.008
P for interaction[4]				0.01			

[1] n = 40 559. Ref, referent. Adjusted RH from Cox proportional hazard regression; adjusted for age, total energy intake, education, family history of breast cancer, BMI, height, parity, age at first live birth, age at menarche, menopausal hormone use, average weekday vigorous physical activity, smoking status, and alcohol use.

[2] All breast cancer cases.

[3] Wald test for linear trend.

[4] Likelihood ratio test comparing the full model with interaction term with the nested model.

TABLE 5
Adjusted relative hazard (RH) of breast cancer by tertiles (T) among consumers compared with never eaters of foods that loaded highest on the traditional southern dietary pattern among postmenopausal women with a BMI < 25 (kg/m^2) in the Breast Cancer Detection Demonstration Project cohort study, 1987–1998[1]

		Adjusted RH (95% CI) for eat at all			
Food item	Never eat	T1	T2	T3	*P* for trend[2]
Foods with positive loadings					
Cooked greens (collard, kale, and mustard)					
No. of cases[3]	747	113	75	89	
Multivariate RH (95% CI)[4]	Ref	1.11 (0.91, 1.35)	0.73 (0.57, 0.92)	0.88 (0.71, 1.10)	0.10
Beans and legumes (pinto, lima, and kidney), baked and cooked					
No. of cases[3]	229	285	266	244	
Multivariate RH (95% CI)[4]	Ref	0.90 (0.75, 1.07)	0.84 (0.70, 1.00)	0.79 (0.66, 0.95)	0.02
Sweet potatoes					
No. of cases[3]	284	253	247	240	
Multivariate RH (95% CI)[4]	Ref	0.89 (0.75, 1.05)	0.85 (0.72, 1.01)	0.84 (0.71, 1.00)	0.14
Corn bread, corn muffins, and corn tortillas					
No. of cases[3]	412	224	198	190	
Multivariate RH (95% CI)[4]	Ref	1.07 (0.90, 1.26)	0.98 (0.82, 1.16)	0.94 (0.79, 1.12)	0.33
Coleslaw, cabbage, and sauerkraut					
No. of cases[3]	176	285	284	279	
Multivariate RH (95% CI)[4]	Ref	0.82 (0.68, 0.99)	0.81 (0.67, 0.98)	0.80 (0.66, 0.97)	0.16[5]
Foods with negative loadings					
Mayonnaise and salad dressing					
No. of cases[3]	123	271	305	325	
Multivariate RH (95% CI)[4]	0.76 (0.61, 0.93)	0.85 (0.73, 1.0)	0.95 (0.81, 1.11)	Ref	0.007
Cheese and cheese spread					
No. of cases[3]	219	249	265	291	
Multivariate RH (95% CI)[4]	0.87 (0.73, 1.05)	0.88 (0.74, 1.04)	0.93 (0.79, 1.10)	Ref	0.08

[1] n = 23 183. Food with |factor loading| > 0.3 (the independent effect of alcohol will be examined in a separate report).
[2] Calculated on the basis of the median value of each category.
[3] All breast cancer cases.
[4] Adjusted RH from Cox proportional hazard regression; adjusted for age, total energy intake, education, family history of breast cancer, BMI, height, parity, age at first live birth, age at menarche, menopausal hormone use, average weekday vigorous physical activity, smoking status, and alcohol use.
[5] The test for trend as a continuous linear trend, rather than categorized, was significant, $P = 0.02$.

drank alcohol by tertiles of intake (*P* for interaction = 0.29). Finally, we examined potential interactions with all other confounders included in the multivariate analyses and observed no evidence ($P > 0.05$) for interactions between any of the other confounders examined (data not shown).

In **Table 5** we present the adjusted RH of breast cancer for each of the foods that loaded highest on the traditional southern pattern among women with a BMI < 25, because we observed evidence of an interaction between BMI and the traditional southern pattern. For all women with a BMI < 25, comparing women in the highest tertile of intake of each food with those who reported no consumption, we observed reduced breast cancer risk associated with higher intake of legumes (RH = 0.79; 95% CI: 0.66, 0.95; *P* for trend = 0.02) and lower intake of mayonnaise–salad dressing (RH = 0.76; 95% CI: 0.61, 0.93; *P* for trend = 0.007). For cabbage intake, the first and second tertiles were also associated with reduced breast cancer risk (RH = 0.82, 95% CI: 0.68, 0.99, and RH = 0.81, 95% CI: 0.67, 0.98, respectively). The test for trend calculated as a continuous linear trend, rather than categorized, was also significant only for cabbage in Table 5 (*P* for linear trend = 0.02). We also observed the suggestion of a reduced breast cancer risk associated with higher intake of cooked greens and sweet potatoes. Similar although less significant results were observed in the full sample of all study participants regardless of BMI (data not shown). Furthermore, in adjusted analyses combining an index of positive intake of legumes and coleslaw-cabbage and the negative of mayonnaise–salad dressing, this pattern was associated with a significantly reduced risk in all women (*P* for linear trend = 0.009) and in women with a BMI < 25 (*P* for linear trend = 0.006). Moreover, the reduced risk for invasive breast cancer associated with the traditional southern diet was attenuated, but still present, when coleslaw-cabbage (*P* linear trend = 0.07), legumes (*P* linear trend = 0.05), and mayonnaise–salad dressing (*P* linear trend = 0.07) were either singly or simultaneously (*P* linear trend = 0.06) adjusted for in the analyses.

In **Table 6** we examine the association between the identified patterns by tumor hormone receptor status. We observed no association between the vegetable-fish/poultry-fruit or beef/pork-starch dietary pattern and either ER- or PR-positive or negative tumors. For the traditional southern dietary pattern, we observed a reduced breast cancer risk associated with this pattern among women with ER-positive tumors (*P* for linear trend = 0.01), PR-positive tumors (*P* for linear trend = 0.003), and ER- and

TABLE 6

Adjusted relative hazard (RH) of breast cancer tumor types by quintiles (Q) of the traditional southern dietary pattern among postmenopausal women in the Breast Cancer Detection Demonstration Project cohort study, 1987–1998[1]

Dietary Pattern	Adjusted RH (95% CI) Q1	Q2	Q3	Q4	Q5	*P* for linear trend[2]
ER+						
No. of cases	212	178	167	151	142	
Adjusted RH (95% CI)[3]	Ref	0.88 (0.72, 1.09)	0.85 (0.69, 1.06)	0.78 (0.62, 0.97)	0.75 (0.59, 0.96)	0.01
ER−						
No. of cases	42	41	41	36	26	
Adjusted RH (95% CI)[3]	Ref	1.06 (0.68, 1.66)	1.14 (0.72, 1.80)	1.03 (0.63, 1.68)	0.78 (0.46, 1.34)	0.41
PR+						
No. of cases	184	142	149	130	110	
Adjusted RH (95% CI)[3]	Ref	0.81 (0.65, 1.02)	0.88 (0.70, 1.11)	0.78 (0.61, 0.99)	0.69 (0.53, 0.89)	0.003
PR−						
No. of cases	66	72	53	51	52	
Adjusted RH (95% CI)[3]	Ref	1.18 (0.83, 1.67)	0.90 (0.61, 1.33)	0.87 (0.59, 1.30)	0.91 (0.60, 1.36)	0.36
ER+ and PR+						
No. of cases	176	132	139	125	107	
Adjusted RH (95% CI)[3]	Ref	0.79 (0.63, 1.01)	0.86 (0.68, 1.09)	0.78 (0.61, 1.01)	0.70 (0.53, 0.91)	0.01
ER− and PR−						
No. of cases	33	31	31	29	22	
Adjusted RH (95% CI)[3]	Ref	1.03 (0.62, 1.72)	1.09 (0.64, 1.85)	1.04 (0.60, 1.80)	0.82 (0.45, 1.49)	0.53
ER− and PR+						
No. of cases	8	9	10	5	3	
Adjusted RH (95% CI)[3]	Ref	1.07 (0.40, 2.83)	1.28 (0.48, 3.40)	0.69 (0.21, 2.23)	0.46 (0.11, 1.86)	0.33
ER+ and PR−						
No. of cases	33	40	21	22	30	
Adjusted RH (95% CI)[3]	Ref	1.29 (0.80, 2.10)	0.70 (0.39, 1.26)	0.72 (0.40, 1.30)	0.99 (0.56, 1.73)	0.55

[1] ER refers to estrogen receptor status and PR to progesterone receptor status; 55% of all cases had information available on ER/PR receptor status. Ref, referent.

[2] Wald test for linear trend.

[3] Adjusted RH from Cox proportional hazard regression; adjusted for age, total energy intake, education, family history of breast cancer, BMI, height, parity, age at first live birth, age at menarche, menopausal hormone use, average weekday vigorous physical activity, smoking status, and alcohol use.

PR-positive tumors (*P* for linear trend = 0.01), but little association among women with ER- or PR-negative tumors, although the sample size for the last-mentioned groups was limited.

DISCUSSION

We identified 3 dietary patterns in a nationwide sample of US women that we labeled vegetable-fish/poultry-fruit, beef/pork-starch, and traditional southern. There was no association between the first 2 patterns and breast cancer risk; however, the traditional southern pattern was associated with a reduced risk among women with invasive breast cancer. This reduced risk was more pronounced in women without a family history of breast cancer, with a BMI < 25, with ER-positive or PR-positive tumors, or who currently smoked. Foods associated with reduced risk in the traditional southern pattern were legumes, low mayonnaise–salad dressing intake, and possibly cabbage.

The 3 dietary patterns observed are consistent with other US studies (15, 16, 28) and are associated with nutritional and demographic characteristics consistent with the literature (41, 46–48). Like our study, another US-wide study observed a southern diet pattern; they reported a reduction in risk for prostate cancer associated with this pattern (*P* for trend = 0.08) (28). Findings are also consistent with previous studies that reported no association between a healthy or prudent and Western or canteen pattern and breast cancer risk (29–31). An Italian study, however, observed a decreased risk associated with a salad vegetable pattern (characterized by raw vegetables and olive oil).

Both in our study and the Italian study (30), reduced risks associated with the traditional southern and salad vegetable patterns were more pronounced among women with a BMI < 25. Given the nearly two-fold increased breast cancer risk associated with obesity in our study sample (data not shown), adipocyte production of estrogen in obese postmenopausal women may mask a diet–breast cancer association (4, 30).

As hypothesized, we observed a more significant reduced risk associated with the traditional southern diet among women without a family history of breast cancer. Similarly, Zhang et al reported a stronger reduced risk associated with dietary antioxidants among premenopausal women with a family history of breast cancer (32). We also observed an interaction between the traditional southern pattern and smoking, which we had not hypothesized. Among current smokers, the traditional southern diet was associated with a reduced risk, possibly because of an increased need for dietary antioxidants (49).

We examined whether specific food constituents of the traditional southern pattern may be associated with a reduced risk of breast cancer. Although results from studies of the association between vegetable intake and breast cancer risk have been mixed (3, 7–9), both the traditional southern and Italian salad vegetable diets loaded highest on vegetables. Cruciferous vegetables and their constituent indoles and isothiocyanates may be protective for breast cancer (6), but recent cohort studies showed a nonsignificantly reduced risk or no association (8, 9). Legumes and their constituent isoflavones (50) may also be protective, but the evidence is again equivocal (8, 51). Comparing the highest quintile of the traditional southern pattern with the vegetable-fish/poultry-fruit diet, mean legume intake was 65% higher, coleslaw-cabbage intake was 9% higher, and mayonnaise–salad dressing intake was 46% lower. The traditional southern diet also loaded negatively on mayonnaise–salad dressing and salty snacks, which are generally higher in *trans* fatty acids and which may increase breast cancer risk (52–54). Given that the reduced risk of invasive breast cancer persisted after adding cabbage, legumes, and mayonnaise–salad dressing singly or in combination to the adjusted analyses, however, the reduced risk associated with the traditional southern pattern does not appear to be due to intake of any one food.

A possible explanation for the lower risk of invasive breast cancer associated with a higher intake of the traditional southern but not the "health-aware" vegetable-fish/poultry-fruit dietary pattern is that the traditional southern pattern may have been more likely to have been initiated during childhood (55). Increasing evidence suggests that childhood diet and growth are associated with breast cancer risk (51, 56). Mishra et al (55) reported that a traditional dietary pattern was more prevalent among manual social class participants and that participants who moved from childhood manual to adult nonmanual social class were more likely to adopt a "health-aware" diet. In our study, given that the traditional southern pattern was associated with lower and the more "health-aware" vegetable-fish/poultry-fruit pattern with higher education, the former diet may better reflect longer term and possibly childhood diet.

Studies have also shown differences in diet–breast cancer associations by tumor hormone receptor status (31, 33, 34, 57–60). We observed reduced risks associated with the traditional southern pattern only among women with tumors that were ER-positive, PR-positive, or both. In other studies, fruit and vegetable intake (33) and fat intake (57) were associated with a higher risk of ER-positive tumors, although conversely, a prudent diet pattern (31), fruit and vegetable intake (59), and low folate intake and high alcohol intake were associated with ER-negative tumors (31, 58). In general, however, hormone-related risk factors (eg, nulliparity, delayed childbearing, obesity, and earlier age at menarche) appear to be more associated with ER- and PR-positive tumors (34, 61). It is possible, therefore, that antiestrogenic properties of the traditional southern diet, perhaps acting early in life (51, 56), lend to the decreased risk we observed for ER- and PR-positive tumors.

Our study has the advantage of being a large, prospective cohort sampled from all regions of the United States and thus representing a diversity of diets. The dietary patterns observed were robust, as shown by their consistency when different and fewer food groups were included in PCFA, when different statistical procedures were applied, and when nearly identical factor loadings were observed in subsamples of women. The effect of measurement error in diet assessment can be reduced when dietary heterogeneity is greater (62), and our population included women from all regions of the United States with very different diets (41, 46). Furthermore, dietary patterns may better capture synergistic interactions of food compounds and effects of different cooking and eating practices on nutrient bioavailability than single nutrients.

The limitations of our findings must also be examined. Dietary intake was self-reported at one point in time from an FFQ. One measure of usual adult diet, rather than continuous measures since childhood, limited our ability to draw inferences about diet–breast cancer associations during different exposure timeframes. Also, although studies have suggested reasonable validity of the FFQ instrument (63), more recent studies using different validation biomarkers have questioned the accuracy of the FFQ for single nutrients (64). The measurement error associated with defining dietary patterns by using PCFA with an FFQ has yet to be quantified. Any measurement error, however, would tend to attenuate diet associations with breast cancer risk (65). Finally, because dietary patterns may be highly correlated with other lifestyle behaviors, dietary pattern–breast cancer associations may also be affected by residual confounding. We adjusted for known confounders in all analyses; nonetheless, it is still possible that residual confounding contributed to the observed associations.

In conclusion, in a nationwide sample of women in the United States, a vegetable-fish/poultry-fruit and a beef/pork-starch dietary pattern were not associated with breast cancer risk. On the other hand, the highest compared with the lowest quintile of intake of the traditional southern pattern was associated with a 22% reduction in risk of invasive breast cancer. The reduced risk associated with this diet pattern was more pronounced among women with a BMI $<$ 25, with no family history of breast cancer, who currently smoked, or had ER- or PR-positive tumors. Foods most associated with reduced risk were higher intake of legumes and cabbage and lower intake of mayonnaise–salad dressing. The reduced risk for invasive breast cancer associated with the traditional southern diet we observed in this cohort study may be due to intake of a specific combination of foods or food components (eg, antioxidants, isoflavones, or isothiocyanates), the diet pattern as a whole, or other unconsidered characteristics of individuals who consume this diet.

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